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TECHNICAL PROPOSAL

NO. TP-5500-2.7

CRYSTAL-VIDEO ANTENNAS

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Prepared for:

25X1

July 1955

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CONFIDENTIALTECHNICAL PROPOSAL NO. TP-5500-2.7CRYSTAL-VIDEO ANTENNAS

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INTRODUCTION

This proposal includes the design and packaging of nine antennas and crystal holders to cover the frequency range from 50 megacycles to 40,000 megacycles. This frequency range is broken up into the following bands: Band 1, 50 to 250 Mc.; Band 2, 250 to 500 Mc.; Band 3, 500 to 1,000 Mc.; Band 4, 1,000 to 2,200 Mc.; Band 5, 2,200 to 4,500 Mc.; Band 6, 4,500 to 10,000 Mc.; Band 7, 10,000 to 18,000 Mc.; Band 8, 18,000 to 26,000 Mc.; Band 9, 26,000 to 40,000 Mc.

It is understood that the frequency range of some of the bands can be varied; e. g., it is proposed to make Band 1, 50 to 160 Mc.; Band 2, 160 to 400 Mc.; Band 3, 400 to 1,000 Mc. However, these new frequency ranges are only tentative.

Four antennas will be required for each band. Each antenna should have 90° beamwidth. The design goal is to achieve at least 45 dbm tangential sensitivity in each band. The discussion to follow is divided into three parts. Part I is a detailed discussion of the antennas proposed for this system. Part II is a detailed discussion of the crystal holders to be used in this system. Part III is a detailed discussion of the over-all packaging of the final system. A supplementary proposal is also attached with a separate budget. This proposal discusses in detail, the design of bandpass filters that could be included in this system

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In order to minimize development costs, we will attempt to use a minimum number of different types of antennas to cover the bands. In the discussion to follow, the bands are broken up into groups

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in which similar antennas are most likely to be used:

a. Band 1 (50 to 160 Mc.)

Considering the frequency range and the bandwidths required, the discone appears to be the logical choice. The discone antenna will make vertical polarization most feasible. The development work will consist mainly of establishing the size and shape of a ground plane to produce a 90° beamwidth and of testing four discones mounted for system use.

b. Bands 2 - 5 (160 to 400 Mc., 400 to 1,000 Mc., 1,000 to 2,200 Mc., 2,200 to 4,500 Mc.)

☐ has developed a conical helix which has been successfully used for bandwidths of 2-1/2:1 in the range from 450 to 5,000 Mc. This helix has the following characteristics:

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1. Very low side lobe levels
2. Circular Polarization with an axial ratio (Power) of 3:1 or less
3. VSWR of 3:1 or less over the band; over most of the band, the VSWR is less than 2:1
4. Half-power beamwidth averages 60° and is practically constant over entire band
5. Extremely rugged construction due to conical shape
6. No external matching transformers required due to unique construction.

This antenna would be satisfactory for Bands 2 - 5, except for the 90° beamwidth requirements. Work has not been done to date, in attempting to broaden the beamwidth of the helix. However, this approach looks very promising. It should be

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emphasized that for the application being considered, circular polarization is desirable and every attempt will be made to achieve circular polarization in Bands 2 - 5. If the above helical antenna runs in to unanticipated difficulties, cross-dipole antennas will be investigated. This antenna also yields circular polarization but requires a balun because of its balanced construction. This might limit its usefulness from impedance standpoint.

In the event that both of the above programs fail to produce a suitable antenna type, linear antennas such as the discone and horn will be considered for these bands. There is no question that a discone can do very nicely for all of the bands, however, horns will be considerably smaller and possibly cheaper due to the 90° beamwidth required. Scale models for all four bands will be constructed and tested both individually and as a group.

c. Band 6 (4,500 to 10,000 Mc.)

A circularly polarized antenna for this band and beamwidth may present a difficult problem. Circularly polarized horns for 2:1 bandwidth operation and for beamwidths of 40° are in use. Due to the limited time available for investigation, we will make a couple attempts at achieving a 90° beamwidth with a circularly polarized horn. If promising results are not forthcoming, attention will be turned to linear horns. Wide-band linear horns have been constructed, using ridged waveguide. Experimental work will have to be done to establish the proper horn and waveguide dimensions for the required 90° beamwidth. No serious problem is anticipated

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using linear horns.

- d. Bands 7 - 9 (10,000 to 13,000 Mc., 13,000 to 26,000 Mc., 26,000 to 40,000 Mc.)

We do not have available at ☐ test equipment over 13,000 Mc. 25X1

We are, therefore, proposing to purchase linear horns to cover these bands from established suppliers. No difficulties are anticipated in these bands.

e. Conclusions

At this writing, it is anticipated that the following antennas will be used in this contract:

- Band 1 Discone Antenna - Vertical Polarization
- Band 2 Tapered Helix - Circular Polarization
- Band 3 Tapered Helix - Circular Polarization
- Band 4 Tapered Helix - Circular Polarization
- Band 5 Tapered Helix - Circular Polarization
- Band 6 Horn - Circular or Linear Polarization
- Band 7 Horn - Horizontal Polarization
- Band 8 Horn - Horizontal Polarization
- Band 9 Horn - Horizontal Polarization

PART II - CRYSTAL HOLDERS

It is proposed to use crystal holders that will be optimum for each band of frequencies. In some cases, this will require some development and special design. We can anticipate achieving a tangential sensitivity greater than 45 dbm over most of the bands of frequencies. Some problems may occur in Band 9.

- a. Bands 1 and 2 - it is proposed to do some development on a crystal holder to cover these two bands. It is planned to use a 1N21B crystal in these bands. No serious technical difficulties are anticipated.

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- b. Bands 3 and 4 - it is proposed to use a UG119/U crystal holder and adapter with a 1N21B crystal for each of these two bands. No development is contemplated and these crystal holders can be built from standard design.
- c. Band 5 - A Grace Mount type of crystal holder using a 1N23B crystal is planned for this band. Again, no development work is contemplated and the crystal holder can be designed from our standard models.
- d. Band 6 - there are available from established suppliers, a couple of designs that should be satisfactory for this band. In particular, we are thinking of a crystal holder manufactured by the F R Machine Shop of New York City. We would plan to use either a 1N23B crystal or a 1N263. In any event, no development work is required.
- e. Bands 7, 8, and 9 - it is planned to purchase these crystal holders from established suppliers. A problem might arise in the Band 9 crystal holder inasmuch as satisfactory crystals are difficult to obtain. However, if necessary, we can achieve an optimum crystal holder with selected crystals.
- f. Conclusions - No difficulties are anticipated in completing the required crystal holders within the time allotted. A small amount of development work is contemplated for Bands 1 and 2, but no technical difficulties are anticipated there. The specifications in connection with tangential sensitivity should be achievable in all bands with the exception of Band 9. Further information will be required before an accurate prediction can be made of tangential sensitivity for Band 9.

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PART III - PACKAGING

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The proposed packaging is illustrated in Figures 1, 2, 3, and 4 attached to this proposal. Figure 1 illustrates the packaging of the band of the proposed Band 1 discone antennas. The unit would consist of four rectangular reflectors which will probably be of mesh or rod construction. These reflectors will be part of the discone antenna and also provide mechanical rigidity for the package. Estimated dimensions are indicated on Figure 1. Figure 2 illustrates the packaging of the Band 2 helical antennas with radomes. These helices are mounted on 3 ft. square plates arranged to form a cube 3 ft. on a side. This packaging allows the helix space plates to become part of the package. Figure 3 illustrates the packaging of the remaining antennas. It is proposed to mount seven antennas on a plate. Each antenna will have its individual radome or window as required for weather-proofing. The plate will probably be a fibre-glass-honey-comb, carbon-filled plate which prevents reflection from metallic surfaces behind the antennas. The use of this plate is a direct result of other packaging work which has performed where similar problems have existed. As in the previous two units, each mounting plate becomes part of the final package. Figure 4 illustrates, in block-diagram form, the complete package. The final package can be constructed by bolting the unit plates together (three sets of four plates) and then fastening the three units together to form a pyramid.

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The advantages of this type of construction are many, but among the more important are:

1. Mechanical stability - the over-all system will be extremely rigid, mechanically.
2. Transportation ease - The required transit cases will be a minimum due to the permanent mounting of most of

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the antennas.

3. Assembly - The assembly of the package will be quite simple due to the box-pyramid construction. All cabling can come down through the inside space.

It is proposed to test the finished system as shown to insure minimum antenna interaction and to check the horizontal antenna patterns for circularity. Impedance and axial ratio measurements will also be made on the final system to assure satisfactory performance.

Both during packaging of the antenna system and after the packaging is completed, effort will be expended toward camouflaging the over-all package in a manner that would make it extremely difficult to determine the use and frequency range of associated equipment from the appearance of the package.

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TOP VIEW () () END VIEW

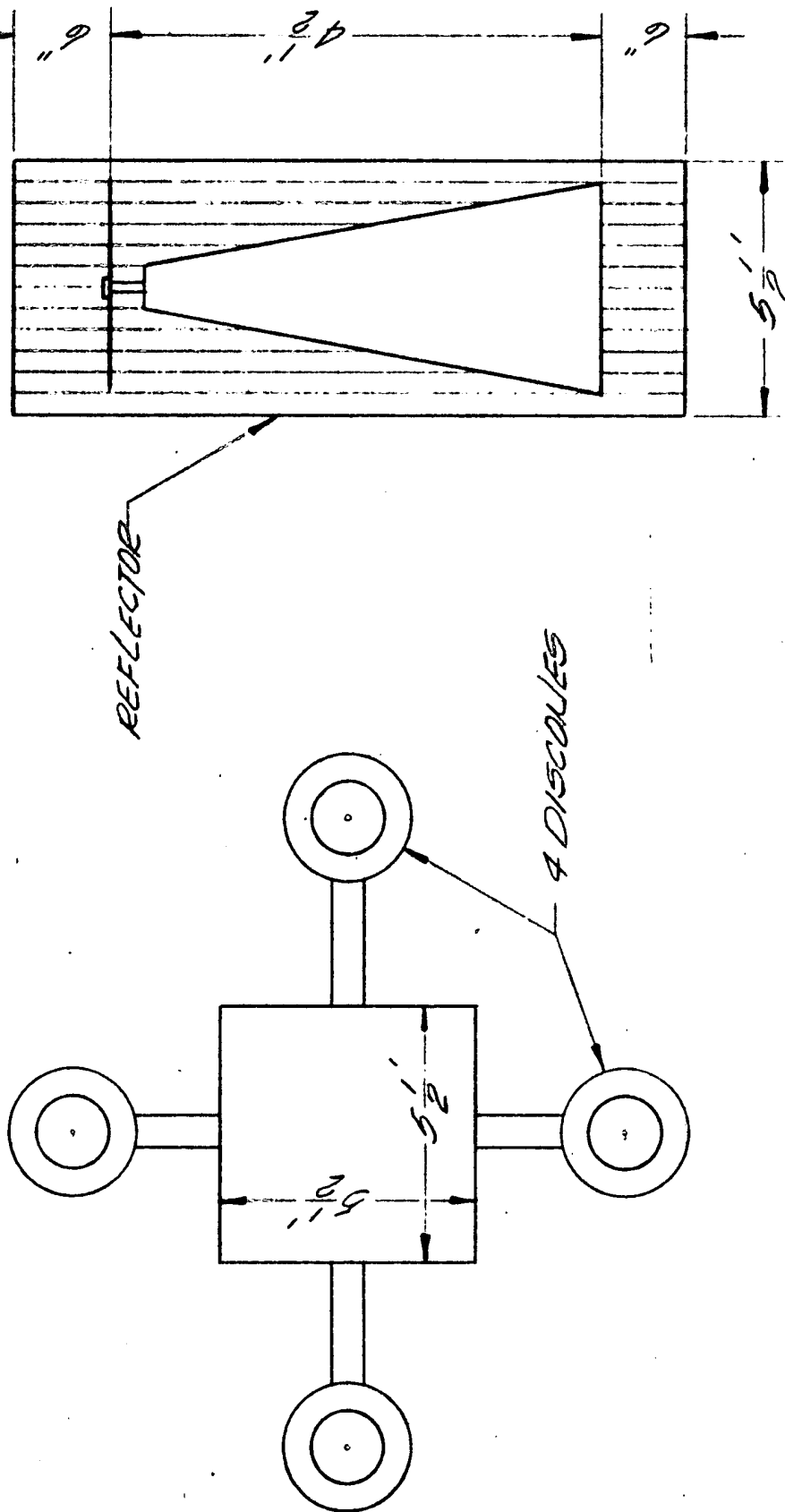
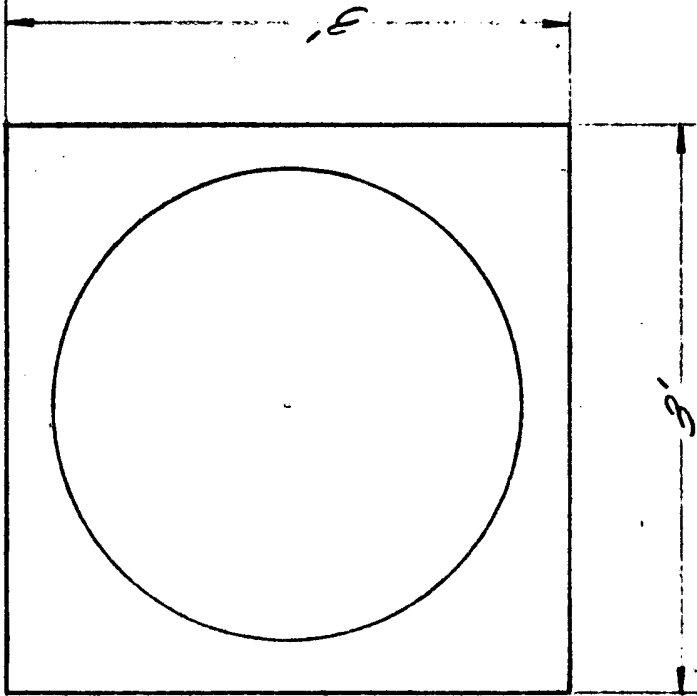


FIG. 1 BAND 1 - DISCONE ANTENNA

REVISIONS		CK. APP.	
<p>UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS IN INCHES TOLERANCES ON FRACTIONS $\pm 1/64$ DECIMALS $\pm .005$ ANGLES $\pm 1/2^\circ$ COMMERCIAL TOLERANCES APPLY ALL STOCK SIZES ALL SURFACES</p>			
MATERIAL		FINISH	
DRAWN <i>EMC</i>		CHECKED <i>JR</i>	
DATE 7/19/55		DATE 7/20/55	
SCALE		PART NO.	
MODEL		DWG. NO.	
APPROVED		DATE	
DATE		DATE	

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END VIEW



TOP VIEW

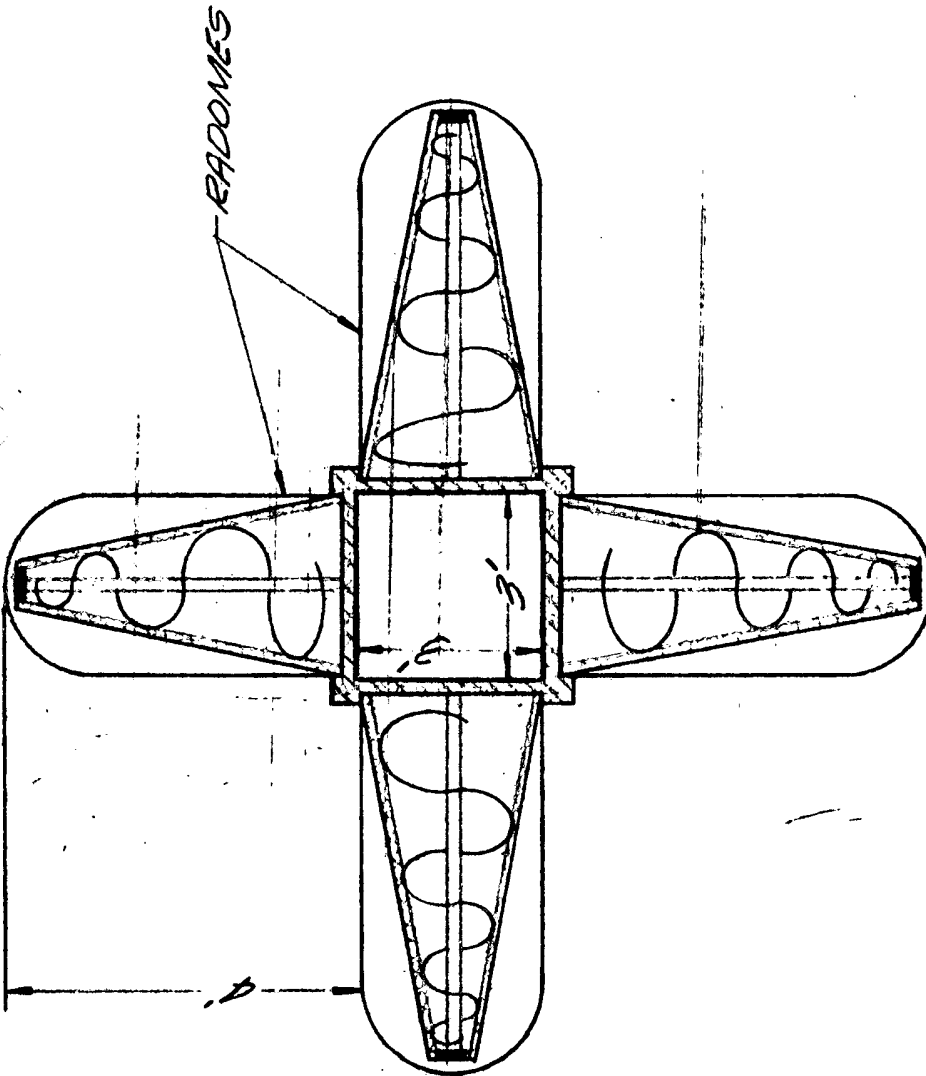


FIG. 2 BAND 2-TAPERED HELICAL ANTENNAS

REVISIONS		CK.	APP.
<p>UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS IN INCHES TOLERANCES ON FRACTIONS $\pm 1/64$ DECIMALS $\pm .005$ ANGLES $\pm 1/2^\circ$ COMMERCIAL TOLERANCES APPLY ALL STOCK SIZES ALL SURFACES</p>			
MATERIAL		FINISH	DATE
DRAWN <i>RMK</i>		DATE <i>7/19/55</i>	DATE <i>7/20/55</i>
SCALE	MODEL	PART NO.	DWG. NO.
APPROVED		DATE	

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END VIEW

TOP VIEW

7 ANTENNAS

RADOME

BAND 3
HELIX

BAND 4
HELIX

BAND 5
HELIX

BAND 6
HORN

BAND 8
HORN

BAND 9
HORN

BAND 7
HORN

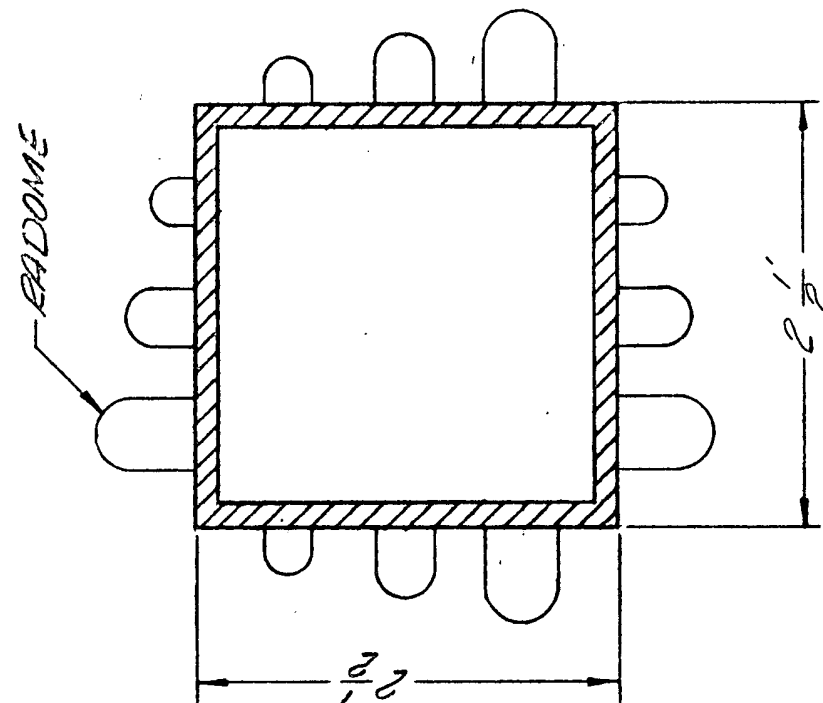


FIG. 3 BANDS 3-9, HORN AND HELICAL ANTENNAS

CK. APP.

REVISIONS

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS IN INCHES
TOLERANCES ON
FRACTIONS $\pm 1/64$
DECIMALS $\pm .005$
ANGLES $\pm 1/2^\circ$
COMMERCIAL TOLERANCES
APPLY ALL STOCK SIZES
ALL SURFACES

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MATERIAL

FINISH

DRAWN

DATE

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DATE

SCALE

MODEL

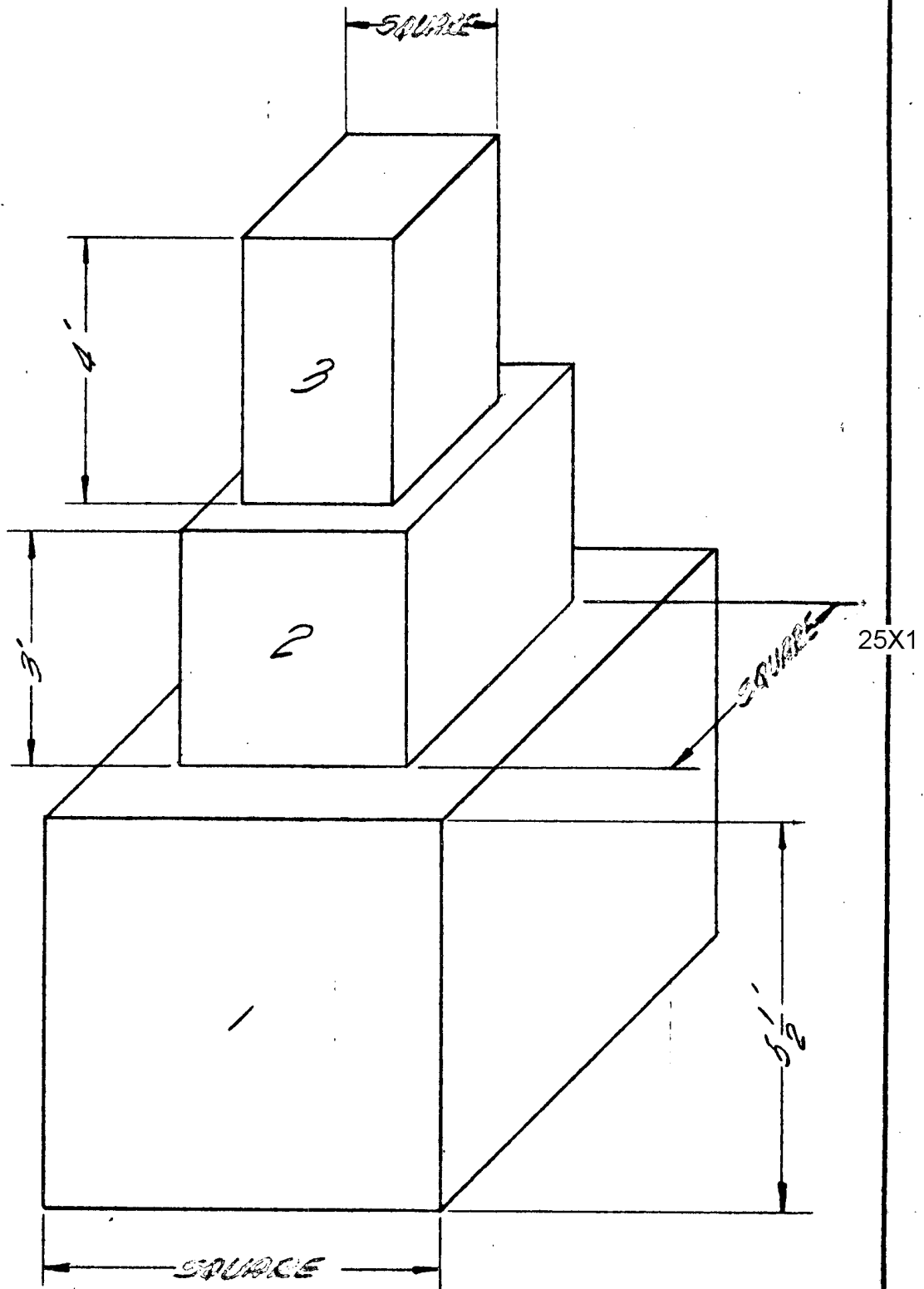
PART NO.

DWG. NO.

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FIG. 4 - BLOCK DIAGRAM OF
COMPLETE SYSTEM

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UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS IN INCHES
TOLERANCES ON
FRACTIONS $\pm 1/64$
DECIMALS $\pm .005$
ANGLES $\pm 1/2^\circ$
COMMERCIAL TOLERANCES
APPLY ALL STOCK SIZES
ALL SURFACES

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DRAWN <i>EMC</i>		DATE <i>7/29/55</i>		CHECKED <i>[Signature]</i>		DATE <i>7/29/55</i>		APPROVED		DATE	
SCALE		MODEL		PART NO.		DWG. NO.					
MATERIAL								FINISH			

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23.6 weeks	Senior Engineer	\$ 4,331.20
16 weeks	Mechanical Engineer	2,160.00
17.2 weeks	Development I Engineer	2,350.00
100.4 weeks	Machinist	9,036.00
30 weeks	Technician	2,520.00
11 weeks	Drafting	<u>362.00</u>
		\$ 21,265.20
Overhead	65%	20,201.94
Materials		15,584.00
Travel and Communications		210.00
Shipping and Crating		<u>300.00</u>
		\$ 37,561.14
Fixed Fee	7%	<u>4,029.27</u>
		\$ 61,590.41
	TOTAL BUDGET	

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CONFIDENTIALPrices for Spare Parts inAntennas Related to TP-5500-2.7

3	Band 1	Discones	\$ 925.00
3	Band 2	Helices and Radomes	771.00
3	Band 3	Helices and Radomes	439.00
3	Band 4	Helices and Radomes	439.00
3	Band 5	Helices and Radomes	439.00
3	Band 6	Horns with Windows	336.00
3	Band 7	Horns with Windows	264.00
3	Band 8	Horns with Windows	264.00
3	Band 9	Horns with Windows	<u>264.00</u>
TOTAL PRICE			\$4191.00

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CONFIDENTIALSUPPLEMENTARY PROPOSAL TO TP-5500-2.7Bandpass Filters (Crystal-Video Antenna System)

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The use of bandpass filters would accurately limit the response of each band to only those frequencies specified for that band. This would eliminate the possibility that a signal would simultaneously be picked up in many different bands. The antenna and crystal holder combination will provide readable reception to frequencies far outside their specified bandwidth. This could conceivably cause operational difficulties. This proposal outlines a program for adding filters to the previous system of antennas and crystal holders.

- a. Band 1 Filter - Some design work is anticipated to produce a filter covering this band. It is anticipated that an insertion loss of better than 4 db can be obtained with an attenuation of greater than 40 db within 10% of the low and high frequency band limits. A lumped parameter filter is planned for this band.
- b. Band 2 - Some design work is anticipated for Band 2 filter. Insertion loss should be better than 4 db in the band and greater than 40 db within 10% of the high frequency and low frequency band limits. A hybrid type of filter using both lumped and distributed parameters is contemplated for this band.
- c. Band 3 - has built an unusual type of lumped-distributed filter covering a bandwidth very similar to this band. The use of this filter is contemplated. A minor amount of design work will be required.

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- d. Band 4 Filter - ☐ has a filter of the lumped-distributed type that can meet the band requirements of Band 4 filter. Insertion loss will be better than 4 db and attenuation greater than 40 db within 10% of band limits. 25X1
- e. Bands 5 and 6 filters - It is planned to use corrugated ridge waveguide filters. ☐ has designed and built many filters of this type. Some design time will be required to accurately set the band limits. Design goals will be better than 4 db insertion loss in the band and between 40 and 60 db attenuation within 10% of the band limits. 25X1
- f. Band 7 - Corrugated waveguide filters will be used with better than 4 db insertion loss in the band and between 40 and 60 db attenuation within 10% of band limits. Some design time will be required to accurately position the band limits of the filter.

Conclusion

No technical difficulties are anticipated in producing filters for this proposal. Some design time will be required to accurately position the lower passband and the upper passband of each filter and to determine the number of sections necessary to obtain the required attenuation outside the passband. If this part of the work is done concurrent with the antenna and crystal holder packaging, there should be no delay in delivering the completed system.

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Proposed Budget for
Supplementary Proposal to TP-5500-2.7

This budget covers all added costs to provide bandpass filters for Bands 1 to 7 inclusive and packaging into the complete system.

5.6 weeks	Senior Engineer	\$ 913.40
2 weeks	Mechanical Engineer	270.00
4.6 weeks	Development I Engineer	575.00
3 weeks	Technician	1,260.00
.3 weeks	Machinist	2,592.00
2 weeks	Drafting	<u>176.00</u>
		\$ 5,791.40
Overhead	95%	5,501.83
Materials		<u>2,745.00</u>
		\$14,038.23
Fixed Fee	7%	<u>982.67</u>
	TOTAL	\$15,020.90

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